

What is claimed is:

1.           An optical module comprising:
  - 2           an under cladding having a flat shape as a
  - 3 whole;
  - 4           a first core which has a quadrangular cross
  - 5 section and is placed on said under cladding;
  - 6           a second core placed on a terminal end portion
  - 7 of said first core; and
  - 8           an over cladding placed in a region including
  - 9 the terminal end portion of said first core and said
  - 10 second core placed on the terminal end portion of said
  - 11 first core,
  - 12           wherein said under cladding and said first
  - 13 core placed thereon constitute a first optical
  - 14 waveguide,
  - 15           said under cladding, the terminal end portion
  - 16 of said first core placed on said under cladding, said
  - 17 second core placed thereon, and said over cladding
  - 18 placed on and around said second core constitute a mode
  - 19 field size conversion portion,
  - 20           said under cladding, said second core placed
  - 21 on said under cladding, and said over cladding placed on
  - 22 and around said second core constitute a second optical
  - 23 waveguide,
  - 24           said first core is made of silicon, and
  - 25           said first and second cores differ in

26 cross-sectional shape.

2. A module according to claim 1, wherein the  
2 terminal end portion is formed from a tapered portion  
3 whose cross-sectional area gradually decreases toward a  
4 distal end thereof.

3. A module according to claim 1, wherein said  
2 over cladding is placed on and around said second core  
3 on said under cladding constituting the second optical  
4 waveguide and said second core on the terminal end  
5 portion constituting the mode field size conversion  
6 portion, and on said first core constituting the first  
7 optical waveguide.

4. A module according to claim 1, wherein said  
2 under cladding is formed on a silicon substrate.

5. A module according to claim 1, wherein said  
2 second core is made of a material higher in refractive  
3 index than said under cladding and lower in refractive  
4 index than silicon of said first core and the terminal  
5 end portion.

6. A module according to claim 1, wherein said  
2 first core and at least a side portion of the terminal  
3 end portion are covered with a silicon oxide film.

7.           A module according to claim 6, wherein said  
2 second core on the terminal end portion is placed on the  
3 silicon oxide film.

8.           A module according to claim 1, wherein said  
2 second core covers a substantially entire region on an  
3 upper surface of the terminal end portion.

9.           A module according to claim 1, wherein said  
2 under cladding is formed from a silicon oxide film.

10.          A module according to claim 1, wherein said  
2 under cladding is formed on a substrate.

11.          A module according to claim 1, wherein a  
2 refractive index of said over cladding is higher than  
3 that of said under cladding.

12.          A module according to claim 1, wherein a  
2 specific refractive index difference between said second  
3 core and said under cladding is larger than that between  
4 said second core and said over cladding.

13.          A module according to claim 3, wherein said  
2 over cladding placed on said core of the first optical  
3 waveguide is continuous with said second core of the

4 second optical waveguide, and said over cladding and  
5 said second core are made of the same material.

14. A module according to claim 13, wherein a  
2 second over cladding is placed on said over cladding  
3 placed on said core of the first optical waveguide and  
4 said second core of said second optical waveguide  
5 continuous with said over cladding, and said second over  
6 cladding is lower in refractive index than said second  
7 core.

15. A module according to claim 13, further  
2 comprising regions where the material for said second  
3 core does not exist at two positions symmetrical with  
4 respect to a traveling direction of light in said second  
5 core.

16. A manufacturing method for an optical module,  
2 comprising the steps of:  
3 forming an under cladding;  
4 selectively forming, on said under cladding, a  
5 first core which has a wire-like shape with a  
6 quadrangular cross section and is made of silicon;  
7 selectively forming a second core on a  
8 terminal end portion of the first core and the under  
9 cladding continuous with the terminal end portion; and  
10 forming an over cladding on and around the

11 second core,  
12 wherein the under cladding and a portion of  
13 the first core which is placed on the under cladding  
14 constitute a first waveguide,  
15 the under cladding, the terminal end portion  
16 of the first core placed thereon, and the second core  
17 placed on the terminal end portion constitute a mode  
18 field size conversion portion,  
19 the under cladding and the second core placed  
20 thereon constitute a second waveguide, and  
21 the first and second cores have different  
22 cross-sectional shapes.

17. A method according to claim 16, further  
2 comprising the step of oxidizing the first core and at  
3 least a side surface of the terminal end portion of the  
4 first core after the step of forming the first core.

18. A method according to claim 16, wherein the  
2 terminal end portion is a tapered portion made of  
3 silicon, whose cross-sectional area gradually decreases  
4 toward a distal end of the first core.

19. A method according to claim 17, wherein the  
2 step of oxidizing the side surface of the terminal end  
3 portion comprises the step of oxidizing the side surface  
4 after masking the first core and an upper surface of the

5 terminal end portion of the first core with an  
6 anti-oxidation film.

20. A method according to claim 17, wherein the  
2 step of oxidizing the first core and the side surface of  
3 the terminal end portion of the first core comprises the  
4 step of oxidizing to cover the first core and the  
5 terminal end portion thereof in addition to the side  
6 surface of the terminal end portion.

21. A method according to claim 17, wherein the  
2 step of oxidizing the first core and the side surface of  
3 the terminal end portion of the first core comprises a  
4 thermal oxidation process.

22. A method according to claim 17, wherein the  
2 step of oxidizing the terminal end portion comprises the  
3 step of oxidizing the first core and a distal end of the  
4 terminal end portion by a width dimension not less than  
5 1/2 that before oxidation.

23. A method according to claim 17, wherein  
2 in the step of forming the first core, a  
3 silicon layer around the first core is left by a  
4 predetermined thickness, and  
5 the step of oxidizing the side surface of the  
6 terminal end portion includes a process of converting

7 the silicon layer having the predetermined thickness and  
8 left around the first core into a silicon oxide film.

24. A method according to claim 23, wherein in the  
2 step of forming the first core, the silicon layer left  
3 around the first core has a thickness not less than 1/2  
4 that of the first core after oxidation.

25. A method according to claim 17, wherein the  
2 step of oxidizing the side surface of the terminal end  
3 portion of the first core includes the step of  
4 increasing a refractive index of a silicon oxide film  
5 formed within a range of refractive indices lower than a  
6 refractive index of silicon.

26. A method according to claim 17, wherein the  
2 step of forming the second core comprises the step of  
3 forming the second core extending to the first core  
4 through the terminal end portion.

27. A method according to claim 26, further  
2 comprising the step of further forming a second over  
3 cladding on the over cladding placed on the core of the  
4 first optical waveguide and the second core of the  
5 second optical waveguide continuous with the first  
6 optical waveguide,  
7 the second over cladding having a refractive

8 index than the second core.

28. A method according to claim 26, further  
2 comprising the step of forming regions where the  
3 material for the second core does not exist at two  
4 positions symmetrical with respect to a traveling  
5 direction of light in the second core.